PATENT ABSTRACTS OF JAPAN

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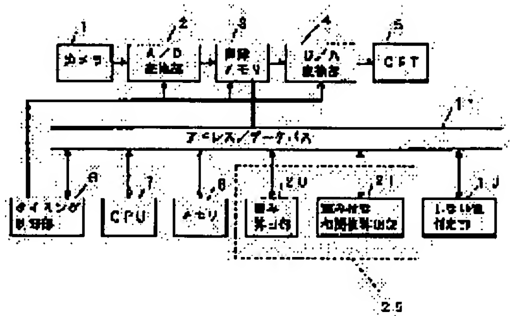
(54) PICTURE PROCESSING METHOD AND DEVICE THEREFOR

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a highly reliable correlation value and to drastically improve the accuracy of recognition.

SOLUTION: This picture processor picks up an image of a pattern printed on a background having patterns by a camera 1 and judges the validity of the printed pattern. A picture obtained by picking up the image of the pattern printed on the background with fixed density is previously stored in a memory 8 as a model picture and an weight calculating part 20 calculates the edge strength of each picture element of the model picture and sets the calculated value as the weight of each picture element. An weighted correlation value calculating part 21 executes normalized mutual correlation operation with the weight set up in each picture element between an input picture and the model picture. A threshold judging part 10 compares the operation result with a prescribed threshold and outputs the judged result.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] After this invention inputs the image which picturized the predetermined observation object and was obtained, it performs the normalization cross-correlation operation between the model images beforehand remembered to be this input image, and relates to the image-processing approach and equipment which judge whether said input image is in agreement with a model image from that result of an operation.
[0002]
[Description of the Prior Art] The equipment which picturizes the alphabetic character and mark which were printed by the goods package etc. with a television camera, processes the obtained image, and performs the quality of said alphabetic character or the printing condition of a mark and recognition of the content of printing exists. When this equipment is memorized in internal memory by having used as the model the image which picturized the object which is in a good printing condition beforehand, and was obtained (this image is called "model image" below) and said image data to be examined is inputted, A normalization cross-correlation operation is performed between this input image and a model image, and recognition processing which distinguishes whether an object is in an input image about that result of an operation as compared with a predetermined threshold, and targets it further using that distinction result is performed.
[0003] Drawing 8 shows the outline configuration of the above-mentioned image processing system, and includes a television camera 1 (only henceforth "a camera 1"), the A/D-conversion section 2, an image memory 3, the D/A converter 4, CRT5, the timing-control section 6, CPU7, memory 8, the correlation value calculation section 9, the threshold judging section 10, the address/data bus 11, etc. as a configuration.
[0004] If a recognition object is picturized with a camera 1, the shade image data of the analog quantity will be inputted into the A/D-conversion section 2, and digital conversion will be carried out. Processing which it is stored in an image memory 3 and mentioned later is performed, and also the input image data of this digital quantity is again changed into the image data of an analog quantity by the D/A converter 4, and is outputted to CRT5. In addition, actuation of said A/D-conversion section 2 and the D/A converter 4 is performed to the timing based on the synchronizing signal outputted from the timing-control section 6.
[0005] The threshold for collating a good printing pattern with memory 8 beforehand as compared with the result of an operation besides the model image picturized and obtained etc. is memorized. The correlation value calculation section 9 inputs the input image in an image memory 3, and the model image in memory 8, respectively, performs the following (1) type among both images, and computes the normalization cross-correlation value CC (only henceforth "the correlation value CC").
[0006]
[Equation 1]

$$CC = \frac{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{I(x, y) - AI\} \{M(x, y) - AM\}}{SI \cdot SM} \quad \cdots\cdot (1)$$

[0007] In addition, in (1) type, mx shows the number of pixels of the direction of a x axis of a model image and an input image, and my shows the number of pixels of y shaft orientations of both images, respectively. Moreover, I (x y) shows the concentration value of the pixel which M (x y) has in the same coordinate location on a model image in the concentration value of the pixel located in the coordinate in an input image (x y) (0 <=x<=mx -1, 0 <=y<=my -1), respectively. Moreover, A.I. Artificial Intelligence, AM, SI, and SM are expressed by the following (2) - (5) type among a top type, respectively.

[0008]

[Equation 2]

$$AI = \frac{1}{mx \times my} \sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} I(x, y) \quad \cdots\cdot (2)$$

[0009]

[Equation 3]

$$AM = \frac{1}{mx \times my} \sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} M(x, y) \quad \cdots\cdot (3)$$

[0010]

[Equation 4]

$$SI = \sqrt{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{I(x, y) - AI\}^2} \quad \cdots\cdot (4)$$

[0011]

[Equation 5]

$$SM = \sqrt{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{M(x, y) - AM\}^2} \quad \cdots\cdot (5)$$

[0012] The covariance calculation section 12 which drawing 9 shows the detailed configuration of said correlation value calculation section 9, and computes the covariance (part of the molecule of the aforementioned (1) formula) of an input image and a model image, The standard deviation calculation section 13 which computes the standard deviation (SI of above (4) and (5) type, SM) of each image, The addition section 14 which computes the part of the denominator of the aforementioned (1) formula by integrating the computed standard deviation SI and SM, and the division section 15 which computes the final result of an operation by inputting the output value of the covariance calculation section 12 and the addition section 14 are included as a configuration.

[0013] The result of an operation CC which the division section 15 outputted, i.e., a correlation value, is incorporated by memory 8 through the address / data bus 11. said threshold judging section 10 carries out reading appearance of this correlation value CC and said threshold from memory 8, compares both, and outputs the signal ("0") which shows that both images are not in agreement in the signal (for example, "1") which shows that an input image is in agreement with a model image with [the correlation value CC] a threshold [more than] when the correlation value CC is less than a threshold, respectively. [for example,] In addition, CPU7 controls actuation of each part of the above to a single

string, and also performs predetermined recognition processing using the decision output of the threshold judging section 10.

[0014]

[Problem(s) to be Solved by the Invention] The above-mentioned correlation value CC has the inclination for the concentration value of an input image for a background to turn into a different value from a model image, when the concentration value of the whole input image changes at a uniform rate by lighting fluctuation etc., it is located on the background for which an object has various concentration values like the print on the package which has a pattern, for example or shading arises into the image part of a background, although not influenced at all. In this case, since the standard deviation of an input image becomes large, even if it is not changing the concentration value of the pixel equivalent to the object in an input image, the value of the correlation value CC becomes small and will cause lowering of recognition precision.

[0015] The figure meaning a concentration value is expressed within the rectangle limit which drawing 10 (1) shows an example of the input image corresponding to [in drawing 10 (2)] this model image for an example of a model image, and indicates each pixel to be also each drawing. In addition, the rectangle G2 with which the rectangle G1 of void was smeared away with the slash in the configuration pixel of the image for a background shows the pixel which constitutes the image of an object among drawing 10 (1) and (2), respectively. Moreover, rectangle G3 smeared away by the halftone dot shows the pixel which has a different concentration value from the response pixel of a model image among the images for a background among drawing 10 (2).

[0016] In the example of a graphic display, although all the concentration values of each pixel of the object part of both images are in agreement, if the normalization cross-correlation operation by the aforementioned (1) formula is performed, the correlation value CC will be set to about 0.79. In this case, if the threshold for a comparison is set up highly, this input image will be distinguished as it is as inharmonious as a model image, consequently incorrect recognition will produce it. A possibility that it may be distinguished if the image which picturized the object with a defect and was obtained on the other hand when the threshold was set up low is also in agreement with a model image arises, and lowering of recognition precision must have been escaped.

[0017] Let it be a technical technical problem for this invention to acquire a reliable correlation value and to improve recognition precision substantially, even if a concentration value changes by part for the background of an input image by having been made paying attention to the above-mentioned trouble, and performing the normalization cross-correlation operation which attached weight to the high pixel of possibility of being equivalent to an object.

[0018]

[Means for Solving the Problem] Invention of claim 1 memorizes beforehand the image with which a predetermined object is included as a model. Input the image which picturized the observation object and was obtained and the normalization cross-correlation operation between this input image and said model image is performed. From the result of an operation, said input image is the approach of judging whether it being in agreement with a model image, and it is characterized by performing said normalization cross-correlation operation by attaching weight to the high pixel of possibility of being equivalent to an object.

[0019] A storage means for invention of claim 2 to be an image processing system for enforcing the above-mentioned approach, and to memorize as a model the image with which a predetermined object is included, An operation means to perform the normalization cross-correlation operation between an image input means to input the image which picturized the observation object and was obtained, and the image inputted by said image input means and the model image of said storage means, It has a judgment means to judge whether said input image is in agreement with a model image with said operation means using the result of an operation, and said operation means is characterized by attaching weight to the high pixel of possibility of being equivalent to an object, and performing said normalization cross-correlation operation.

[0020] In invention of claim 3, said operation means performs the normalization cross-correlation

operation which attached said computed weight to each pixel between a model image and an input image, after computing the edge reinforcement of each pixel of said model image as weight of each pixel.

[0021] In invention of claim 4, said operation means performs the normalization cross-correlation operation which attached said computed weight to each pixel between a model image and an input image, after computing the distance over the background of each pixel of said model image as weight of each pixel from the binary-ized image of said model image.

[0022]

[Function] Since weight is attached to the pixel which may be equivalent to an object and a normalization cross-correlation operation is performed It is located on a background with a complicated object, or shading arises. If it is changing at a rate with the concentration value of each pixel equivalent to an object the concentration value of the pixel equivalent to an object is the same as that of a model image, or uniform even when the concentration value for a background of an input image is changed to a different value from a model image The result that high correlation is between an input image and a model image will be obtained.

[0023] In invention of claim 3, by invention of claim 4, distance [as opposed to the background of each pixel for the edge reinforcement of each pixel of a model image] is computed from the binary-ized image of a model image, respectively, high weight will be attached to the pixel which may be equivalent to an object since a normalization cross-correlation operation is performed as weight of each pixel in this computed value, and the aforementioned data processing can be realized.

[0024]

[Embodiment of the Invention] As an example for carrying out this invention, the image processing system shown in drawing 1 is mentioned. This image processing system performs the normalization cross-correlation operation which attached predetermined weight to each pixel between the input image in an image memory 3, and the model image in memory 8, and the weight calculation section 20 computes the edge reinforcement of each pixel of a model image, and sets this up as weight of each pixel. The correlation value calculation section 21 with weight attaches the weight set as each pixel, and performs a normalization cross-correlation operation, and the threshold judging section 10 outputs the judgment result for the result of an operation as compared with a predetermined threshold.

[0025]

[Example] Drawing 1 shows the outline configuration of the image processing system concerning one example of this invention. This image processing system is replaced with the correlation value calculation section 9 of the conventional configuration which is for judging the quality of patterns, such as an alphabetic character printed on the background with a pattern, and was shown in drawing 8 , and the operation part 25 which consists of the weight calculation section 20 and the correlation value calculation section 21 with weight is provided. In addition, about other configurations, detailed explanation is omitted by attaching the sign being the same as that of the conventional example, and same to each part here as drawing 8 .

[0026] The image which this image processing system picturized the pattern printed on the background of uniform concentration, and was obtained So that the correlation value which can set dependability even if it has registered into memory 8 as a model image and a difference is in the concentration value for a background between an input image and a model image may be acquired It is made to perform the normalization cross-correlation operation (for the correlation value acquired by this operation below to be called "correlation value with weight") which attached weight to the pixel equivalent to the printing pattern for recognition.

[0027] Said weight calculation section 20 is for computing the weight for every pixel using said model image, and this calculation result is memorized in memory 8 as image data which has the same magnitude as a model image (this image data is called "weight image" below).

[0028] The correlation value calculation section 21 with weight inputs the input image stored in the image memory 3, and the model image and weight image which were memorized by memory 8, performs the following (6) types between an input image and a model image, and computes the

correlation value WCC with weight.
[0029]
[Equation 6]

$$WCC=\frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}[W(x,y)\cdot\{I(x,y)-WAI\}\{M(x,y)-WAM\}]}{WSI\cdot WSM}\quad\cdots(6)$$

[0030] In addition, in the above-mentioned (6) formula, mx, my, I (x y), and M (x y) are the variables based on the same definition as the above (1). Moreover, W (x y) is the weight computed about the pixel located in the coordinate (x y) of said weight image, and WAI, WAM, WSI, and WSM are expressed by the following (7) - (10) type.
[0031]
[Equation 7]

$$WAI=\frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{W(x,y)\cdot I(x,y)\}}{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}W(x,y)}\quad\cdots(7)$$

[0032]
[Equation 8]

$$WAM=\frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{W(x,y)\cdot M(x,y)\}}{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}W(x,y)}\quad\cdots(8)$$

[0033]
[Equation 9]

$$WSI=\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}[W(x,y)\cdot\{I(x,y)-WAI\}^2]}\quad\cdots(9)$$

[0034]
[Equation 10]

$$WSM=\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}[W(x,y)\cdot\{M(x,y)-WAM\}^2]}\quad\cdots(10)$$

[0035] Drawing 2 shows the detailed configuration of said correlation value calculation section 21 with weight, and possesses the same addition section 14 of a configuration as said drawing 9 besides the covariance calculation section 22 with weight, and the standard deviation calculation section 23 with weight, and the division section 15.

[0036] The covariance calculation section 22 with weight and the standard deviation calculation section 23 with weight It is what both inputs each image data of an input image, a model image, and a weight image. By the covariance calculation section 22 with weight, the covariance with weight of an input image and a model image (part of the molecule of the aforementioned (3) formula) The standard deviations WSI and WSM (result of an operation of above (9) and (10) type) with weight about an input image and each model image are computed by the standard-deviation calculation section 23 with weight, respectively. The denominator part of the aforementioned (6) formula is computed by the addition section 14 integrating this standard deviation WSI and WSM with weight, and the division section 15 computes the final result of an operation WCC, i.e., a correlation value with weight, by inputting each output value of the covariance calculation section 22 with weight, and the addition section 14.
[0037] The weight calculation approach of each pixel by said weight calculation section 20 is explained below. In this example, as described above, the image of the pattern printed in the condition good on the background which has a uniform concentration value as a model image is memorized in memory 8, and the weight calculation section 20 is computing the edge reinforcement of each pixel of a model image as weight of each pixel.
[0038] This edge reinforcement is obtained by performing the following (11) types in each scan location, and in order to compute the edge reinforcement of the pixel located in the edge of a model image in this case, it generates the image which extended only 1 pixel of model images in four-directions each direction, and he is trying to scan the 3 pixel x3 pixel Sobel operator in a model image, and to scan said Sobel operator on this extended image.
[0039] Drawing 3 shows the example which extended the model image (image constituted by the pixel of the thick wire in drawing within the limit) which takes the same data configuration as said drawing 10 (1), and has arranged the pixel which has the same concentration as the pixel near the outside of each pixel located in an edge. In addition, inside of (11) types and Dx When it laps with the 3 pixel x3 pixel image field which said Sobel operator shows to drawing 4 , the differential value in the direction of a x axis of the pixel (pixel located in a coordinate (x y)) of the center of this image field is shown. Moreover, Dy Similarly the differential value in y shaft orientations of a central pixel is shown, and they are Dx and Dy. It is computed by (12) and (13) types, respectively.
[0040]
[Equation 11]

$$W(x, y) = D_x(x, y) + D_y(x, y) \quad \cdots (11)$$

[0041]
[Equation 12]

$$D_x(x, y) = |M(x+1, y-1) + 2M(x+1, y) + M(x+1, y+1) - M(x-1, y-1) - 2M(x-1, y) - M(x-1, y+1)| \quad \cdots (12)$$

[0042]
[Equation 13]

$$D_y(x, y) = |M(x+1, y+1) + 2M(x, y+1) + M(x-1, y+1) - M(x+1, y-1) - 2M(x, y-1) - M(x-1, y-1)| \quad \cdots (13)$$

[0043] The weight image which drawing 5 computed the weight of each pixel by the above-mentioned approach to the model image of said drawing 10 (1), and was obtained is shown, and the weight of the pixel which constitutes the background of the pixel corresponding to a printing pattern and its near becomes high by the above-mentioned data processing. Moreover, the weight of the pixel in which each of 8 pixels of near has the same concentration value is set to "0" among the pixels which constitute a background.
[0044] In addition, calculation of edge reinforcement may be other operators, such as not only the Sobel operator but a gradient. Moreover, weighting to each pixel computes the distance over a part for the background of each pixel in the image obtained by making binary not only edge reinforcement but a model image, and is good also considering this as weight of each pixel.
[0045] Drawing 6 shows the weight image set up about the model image of said drawing 10 (1) in quest of the distance over a part for the background described above for every pixel. In this case, the weight of the pixel from which the weight of the pixel for a background constitutes the profile of "0" and an object is set to "1", and as high weight as the pixel located in the interior of an object is given.
[0046] If (6) types are performed using the weight image of drawing 5 to the model image and input image which were shown in said drawing 10 (1) and (2), the weighting correlation value WCC will be set to about 0.93. Moreover, the weighting correlation value WCC at the time of computing using the weight image of drawing 6 is 1.0.
[0047] Drawing 7 shows the example from which the concentration value of the whole input image became half [of the model image shown in drawing 10 (1)]. Also when the aforementioned (6) formula is performed using said drawing 5 and the weight image of 6 between this input image and a model image, the same calculation result as the above can be obtained. Thus, if the normalization cross-correlation operation which attached weight to the high pixel of possibility of being equivalent to the object for recognition is performed, the correlation value which does not receive effect in fluctuation of the concentration value of the whole input image by lighting fluctuation etc., either can be acquired also to fluctuation of some concentration values for a background, and recognition precision will improve substantially.
[0048] In addition, it memorizes to ROM which does not illustrate the program for computing calculation of the weight of each pixel, and the weighting correlation value WCC instead of the operation part 25 of the above-mentioned example, and may be made to perform this program by CPU7.

[0049]
[Effect of the Invention] In case it judges whether this invention performs the normalization cross-correlation operation of an input image and a model image like the above, and its input image corresponds with a model image Since weight is attached to the high pixel of possibility of being equivalent to an object and it was made to perform said normalization cross-correlation operation, even if the concentration value for a background in an input image turns into a different value from a model image The concentration of the pixel equivalent to an object is the same as that of a model image, or if the rate of the concentration value change of each pixel equivalent to an object is uniform, a high correlation value is acquired and the recognition precision of an input image can be improved substantially.
[0050] Since weighting of the value which computed distance [as opposed to the background of each pixel for the edge reinforcement of each pixel of a model image], respectively, and was computed by each pixel is carried out and a normalization cross-correlation operation is performed from the binary-ized image of a model image by invention of claim 4 by invention of claim 3, weighting high to the high pixel of possibility of being equivalent to an object is made, and the above-mentioned data processing can be realized.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] After this invention inputs the image which picturized the predetermined observation object and was obtained, it performs the normalization cross-correlation operation between the model images beforehand remembered to be this input image, and relates to the image-processing approach and equipment which judge whether said input image is in agreement with a model image from that result of an operation.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The equipment which picturizes the alphabetic character and mark which were printed by the goods package etc. with a television camera, processes the obtained image, and performs the quality of said alphabetic character or the printing condition of a mark and recognition of the content of printing exists. When this equipment is memorized in internal memory by having used as the model the image which picturized the object which is in a good printing condition beforehand, and was obtained (this image is called "model image" below) and said image data to be examined is inputted, A normalization cross-correlation operation is performed between this input image and a model image, and recognition processing which distinguishes whether an object is in an input image about that result of an operation as compared with a predetermined threshold, and targets it further using that distinction result is performed.
[0003] Drawing 8 shows the outline configuration of the above-mentioned image processing system, and includes a television camera 1 (only henceforth "a camera 1"), the A/D-conversion section 2, an image memory 3, the D/A converter 4, CRT5, the timing-control section 6, CPU7, memory 8, the correlation value calculation section 9, the threshold judging section 10, the address/data bus 11, etc. as a configuration.
[0004] If a recognition object is picturized with a camera 1, the shade image data of the analog quantity will be inputted into the A/D-conversion section 2, and digital conversion will be carried out. Processing which it is stored in an image memory 3 and mentioned later is performed, and also the input image data of this digital quantity is again changed into the image data of an analog quantity by the D/A converter 4, and is outputted to CRT5. In addition, actuation of said A/D-conversion section 2 and the D/A converter 4 is performed to the timing based on the synchronizing signal outputted from the timing-control section 6.
[0005] The threshold for collating a good printing pattern with memory 8 beforehand as compared with the result of an operation besides the model image picturized and obtained etc. is memorized. The correlation value calculation section 9 inputs the input image in an image memory 3, and the model image in memory 8, respectively, performs the following (1) type among both images, and computes the normalization cross-correlation value CC (only henceforth "the correlation value CC").
[0006]
[Equation 1]

$$CC = \frac{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{I(x,\ y) - AI\} \{M(x,\ y) - AM\}}{SI \cdot SM} \quad \cdots\cdots (1)$$

[0007] In addition, in (1) type, mx shows the number of pixels of the direction of a x axis of a model image and an input image, and my shows the number of pixels of y shaft orientations of both images, respectively. Moreover, I (x y) shows the concentration value of the pixel which M (x y) has in the same

coordinate location on a model image in the concentration value of the pixel located in the coordinate in an input image (x y) ($0 <= x <= mx - 1$, $0 <= y <= my - 1$), respectively. Moreover, A.I. Artificial Intelligence, AM, SI, and SM are expressed by the following (2) - (5) type among a top type, respectively.

[0008]

[Equation 2]

$$AI = \frac{1}{mx \times my} \sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} I(x, y) \quad \cdots (2)$$

[0009]

[Equation 3]

$$AM = \frac{1}{mx \times my} \sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} M(x, y) \quad \cdots (3)$$

[0010]

[Equation 4]

$$SI = \sqrt{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{I(x, y) - AI\}^2} \quad \cdots (4)$$

[0011]

[Equation 5]

$$SM = \sqrt{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{M(x, y) - AM\}^2} \quad \cdots (5)$$

[0012] The covariance calculation section 12 which drawing 9 shows the detailed configuration of said correlation value calculation section 9, and computes the covariance (part of the molecule of the aforementioned (1) formula) of an input image and a model image, The standard deviation calculation section 13 which computes the standard deviation (SI of above (4) and (5) type, SM) of each image, The addition section 14 which computes the part of the denominator of the aforementioned (1) formula by integrating the computed standard deviation SI and SM, and the division section 15 which computes the final result of an operation by inputting the output value of the covariance calculation section 12 and the addition section 14 are included as a configuration.

[0013] The result of an operation CC which the division section 15 outputted, i.e., a correlation value, is incorporated by memory 8 through the address / data bus 11. said threshold judging section 10 carries out reading appearance of this correlation value CC and said threshold from memory 8, compares both, and outputs the signal ("0") which shows that both images are not in agreement in the signal (for example, "1") which shows that an input image is in agreement with a model image with [the correlation value CC] a threshold [more than] when the correlation value CC is less than a threshold, respectively. [for example,] In addition, CPU7 controls actuation of each part of the above to a single string, and also performs predetermined recognition processing using the decision output of the threshold judging section 10.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] In case it judges whether this invention performs the normalization cross-correlation operation of an input image and a model image like the above, and its input image corresponds with a model image Since weight is attached to the high pixel of possibility of being equivalent to an object and it was made to perform said normalization cross-correlation operation, even if the concentration value for a background in an input image turns into a different value from a model image The concentration of the pixel equivalent to an object is the same as that of a model image, or if the rate of the concentration value change of each pixel equivalent to an object is uniform, a high correlation value is acquired and the recognition precision of an input image can be improved substantially.
[0050] Since weighting of the value which computed distance [as opposed to the background of each pixel for the edge reinforcement of each pixel of a model image], respectively, and was computed by each pixel is carried out and a normalization cross-correlation operation is performed from the binary-ized image of a model image by invention of claim 4 by invention of claim 3, weighting high to the high pixel of possibility of being equivalent to an object is made, and the above-mentioned data processing can be realized.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The above-mentioned correlation value CC has the inclination for the concentration value of an input image for a background to turn into a different value from a model image, when the concentration value of the whole input image changes at a uniform rate by lighting fluctuation etc., it is located on the background for which an object has various concentration values like the print on the package which has a pattern, for example or shading arises into the image part of a background, although not influenced at all. In this case, since the standard deviation of an input image becomes large, even if it is not changing the concentration value of the pixel equivalent to the object in an input image, the value of the correlation value CC becomes small and will cause lowering of recognition precision.
[0015] The figure meaning a concentration value is expressed within the rectangle limit which drawing 10 (1) shows an example of the input image corresponding to [in drawing 10 (2)] this model image for an example of a model image, and indicates each pixel to be also each drawing. In addition, the rectangle G2 with which the rectangle G1 of void was smeared away with the slash in the configuration pixel of the image for a background shows the pixel which constitutes the image of an object among drawing 10 (1) and (2), respectively. Moreover, rectangle G3 smeared away by the halftone dot shows the pixel which has a different concentration value from the response pixel of a model image among the images for a background among drawing 10 (2).
[0016] In the example of a graphic display, although all the concentration values of each pixel of the object part of both images are in agreement, if the normalization cross-correlation operation by the aforementioned (1) formula is performed, the correlation value CC will be set to about 0.79. In this case, if the threshold for a comparison is set up highly, this input image will be distinguished as it is as inharmonious as a model image, consequently incorrect recognition will produce it. A possibility that it may be distinguished if the image which picturized the object with a defect and was obtained on the other hand when the threshold was set up low is also in agreement with a model image arises, and lowering of recognition precision must have been escaped.
[0017] Let it be a technical technical problem for this invention to acquire a reliable correlation value and to improve recognition precision substantially, even if a concentration value changes by part for the background of an input image by having been made paying attention to the above-mentioned trouble, and performing the normalization cross-correlation operation which attached weight to the high pixel of possibility of being equivalent to an object.

[Translation done.]

OPERATION

[Function] Since weight is attached to the pixel which may be equivalent to an object and a normalization cross-correlation operation is performed It is located on a background with a complicated object, or shading arises. If it is changing at a rate with the concentration value of each pixel equivalent to an object the concentration value of the pixel equivalent to an object is the same as that of a model image, or uniform even when the concentration value for a background of an input image is changed to a different value from a model image The result that high correlation is between an input image and a model image will be obtained.
[0023] In invention of claim 3, by invention of claim 4, distance [as opposed to the background of each pixel for the edge reinforcement of each pixel of a model image] is computed from the binary-ized image of a model image, respectively, high weight will be attached to the pixel which may be equivalent to an object since a normalization cross-correlation operation is performed as weight of each pixel in this computed value, and the aforementioned data processing can be realized.
[0024]
[Embodiment of the Invention] As an example for carrying out this invention, the image processing system shown in drawing 1 is mentioned. This image processing system performs the normalization cross-correlation operation which attached predetermined weight to each pixel between the input image in an image memory 3, and the model image in memory 8, and the weight calculation section 20 computes the edge reinforcement of each pixel of a model image, and sets this up as weight of each pixel. The correlation value calculation section 21 with weight attaches the weight set as each pixel, and performs a normalization cross-correlation operation, and the threshold judging section 10 outputs the judgment result for the result of an operation as compared with a predetermined threshold.

[Translation done.]

MEANS

[Means for Solving the Problem] Invention of claim 1 memorizes beforehand the image with which a predetermined object is included as a model. Input the image which picturized the observation object and was obtained and the normalization cross-correlation operation between this input image and said model image is performed. From the result of an operation, said input image is the approach of judging whether it being in agreement with a model image, and it is characterized by performing said normalization cross-correlation operation by attaching weight to the high pixel of possibility of being equivalent to an object.
[0019] A storage means for invention of claim 2 to be an image processing system for enforcing the above-mentioned approach, and to memorize as a model the image with which a predetermined object is included, An operation means to perform the normalization cross-correlation operation between an image input means to input the image which picturized the observation object and was obtained, and the image inputted by said image input means and the model image of said storage means, It has a judgment means to judge whether said input image is in agreement with a model image with said operation means using the result of an operation, and said operation means is characterized by attaching weight to the high pixel of possibility of being equivalent to an object, and performing said normalization cross-correlation operation.
[0020] In invention of claim 3, said operation means performs the normalization cross-correlation operation which attached said computed weight to each pixel between a model image and an input image, after computing the edge reinforcement of each pixel of said model image as weight of each pixel.
[0021] In invention of claim 4, said operation means performs the normalization cross-correlation operation which attached said computed weight to each pixel between a model image and an input image, after computing the distance over the background of each pixel of said model image as weight of each pixel from the binary-ized image of said model image.

[Translation done.]

EXAMPLE

[Example] Drawing 1 shows the outline configuration of the image processing system concerning one example of this invention. This image processing system is replaced with the correlation value calculation section 9 of the conventional configuration which is for judging the quality of patterns, such as an alphabetic character printed on the background with a pattern, and was shown in drawing 8 , and the operation part 25 which consists of the weight calculation section 20 and the correlation value calculation section 21 with weight is provided. In addition, about other configurations, detailed explanation is omitted by attaching the sign being the same as that of the conventional example, and same to each part here as drawing 8 .
[0026] The image which this image processing system picturized the pattern printed on the background of uniform concentration, and was obtained So that the correlation value which can set dependability even if it has registered into memory 8 as a model image and a difference is in the concentration value for a background between an input image and a model image may be acquired It is made to perform the normalization cross-correlation operation (for the correlation value acquired by this operation below to be called "correlation value with weight") which attached weight to the pixel equivalent to the printing pattern for recognition.
[0027] Said weight calculation section 20 is for computing the weight for every pixel using said model image, and this calculation result is memorized in memory 8 as image data which has the same magnitude as a model image (this image data is called "weight image" below).
[0028] The correlation value calculation section 21 with weight inputs the input image stored in the image memory 3, and the model image and weight image which were memorized by memory 8, performs the following (6) types between an input image and a model image, and computes the correlation value WCC with weight.
[0029]
[Equation 6]

$$WCC = \frac{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \left[W(x, y) \cdot \{ I(x, y) - WAI \} \{ M(x, y) - WAM \} \right]}{WSI \cdot WSM} \quad \cdots\cdots (6)$$

[0030] In addition, in the above-mentioned (6) formula, mx, my, I (x y), and M (x y) are the variables based on the same definition as the above (1). Moreover, W (x y) is the weight computed about the pixel located in the coordinate (x y) of said weight image, and WAI, WAM, WSI, and WSM are expressed by the following (7) - (10) type.
[0031]
[Equation 7]

$$WAI = \frac{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{W(x, y) \cdot I(x, y)\}}{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} W(x, y)} \quad \cdots (7)$$

[0032]
[Equation 8]

$$WAM = \frac{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{W(x, y) \cdot M(x, y)\}}{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} W(x, y)} \quad \cdots (8)$$

[0033]
[Equation 9]

$$WSI = \sqrt{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} [W(x, y) \cdot \{I(x, y) - WAI\}^2]} \quad \cdots (9)$$

[0034]
[Equation 10]

$$WSM = \sqrt{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} [W(x, y) \cdot \{M(x, y) - WAM\}^2]} \quad \cdots (10)$$

[0035] Drawing 2 shows the detailed configuration of said correlation value calculation section 21 with weight, and possesses the same addition section 14 of a configuration as said drawing 9 besides the covariance calculation section 22 with weight, and the standard deviation calculation section 23 with weight, and the division section 15.
[0036] The covariance calculation section 22 with weight and the standard deviation calculation section 23 with weight It is what both inputs each image data of an input image, a model image, and a weight image. By the covariance calculation section 22 with weight, the covariance with weight of an input image and a model image (part of the molecule of the aforementioned (3) formula) The standard deviations WSI and WSM (result of an operation of above (9) and (10) type) with weight about an input image and each model image are computed by the standard-deviation calculation section 23 with weight, respectively. The denominator part of the aforementioned (6) formula is computed by the addition section 14 integrating this standard deviation WSI and WSM with weight, and the division section 15 computes the final result of an operation WCC, i.e., a correlation value with weight, by inputting each output value of the covariance calculation section 22 with weight, and the addition section 14.
[0037] The weight calculation approach of each pixel by said weight calculation section 20 is explained below. In this example, as described above, the image of the pattern printed in the condition good on the background which has a uniform concentration value as a model image is memorized in memory 8, and the weight calculation section 20 is computing the edge reinforcement of each pixel of a model image as weight of each pixel.
[0038] This edge reinforcement is obtained by performing the following (11) types in each scan location, and in order to compute the edge reinforcement of the pixel located in the edge of a model image in this case, it generates the image which extended only 1 pixel of model images in four-

directions each direction, and he is trying to scan the 3 pixel x3 pixel Sobel operator in a model image, and to scan said Sobel operator on this extended image.
[0039] Drawing 3 shows the example which extended the model image (image constituted by the pixel of the thick wire in drawing within the limit) which takes the same data configuration as said drawing 10 (1), and has arranged the pixel which has the same concentration as the pixel near the outside of each pixel located in an edge.

DESCRIPTION OF DRAWINGS

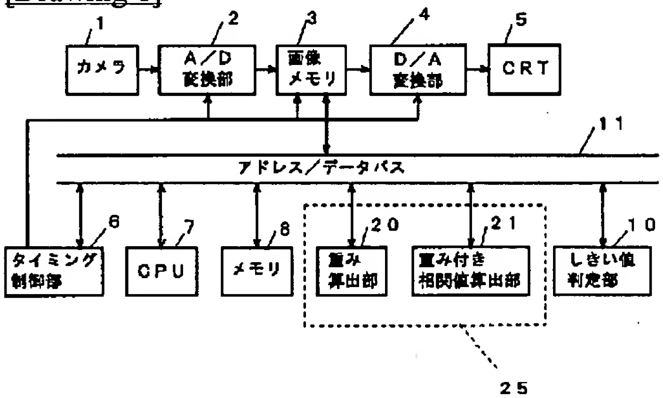
[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the outline configuration of the image processing system concerning one example of this invention.
[Drawing 2] It is the block diagram showing the detailed configuration of the correlation value calculation section with weight.
[Drawing 3] It is the explanatory view showing the extended example of a model image.
[Drawing 4] It is the explanatory view showing the physical relationship of the pixel and the pixel of near for [of edge reinforcement] an extract.
[Drawing 5] It is the explanatory view showing the example of a data configuration of a weight image.
[Drawing 6] It is the explanatory view showing the example of a data configuration of a weight image.
[Drawing 7] It is the explanatory view showing the example of a data configuration of an input image.
[Drawing 8] It is the block diagram showing the outline configuration of the conventional image processing system.
[Drawing 9] It is the block diagram showing the detailed configuration of the correlation value calculation section.
[Drawing 10] It is the explanatory view showing the example of a data configuration of a model image and an input image.
[Description of Notations]
7 CPU
10 Threshold Judging Section
20 Weight Calculation Section
21 Correlation Value Calculation Section with Weight

[Translation done.]

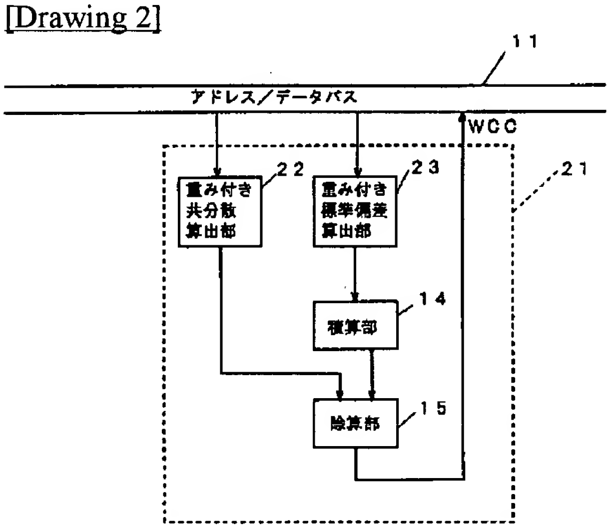
* NOTICES *

DRAWINGS

[Drawing 1]



[Drawing 2]



[Drawing 3]

200	200	200	200	200	200	200	200	200	200
200	200	200	200	200	200	200	200	200	200
200	200	200	200	200	200	200	200	200	200
200	200	200	200	200	200	200	200	200	200
200	200	200	200	200	200	200	200	200	200
200	200	200	200	30	30	30	30	30	30
200	200	200	200	30	20	20	20	20	20
200	200	200	200	30	20	10	10	10	10
200	200	200	200	30	20	10	200	200	200
200	200	200	200	30	20	10	200	200	200

[Drawing 4]

(x−1, y−1)	(x, y−1)	(x+1, y−1)
(x−1, y)	(x, y)	(x+1, y)
(x−1, y+1)	(x, y+1)	(x+1, y+1)

[Drawing 5]

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	340	680	680	680	680	680
0	0	680	1040	720	720	720	720
0	0	680	720	80	80	80	80
0	0	680	720	80	320	720	720
0	0	680	720	80	720	1140	760

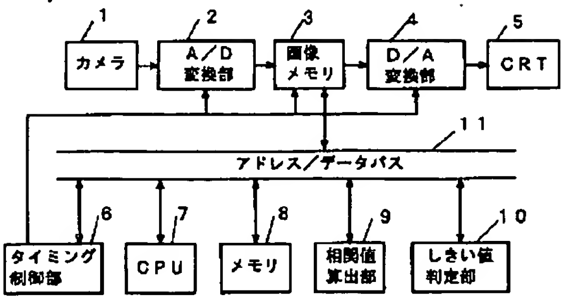
[Drawing 6]

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1
0	0	0	1	2	2	2	2
0	0	0	1	2	1	1	1
0	0	0	1	2	1	0	0

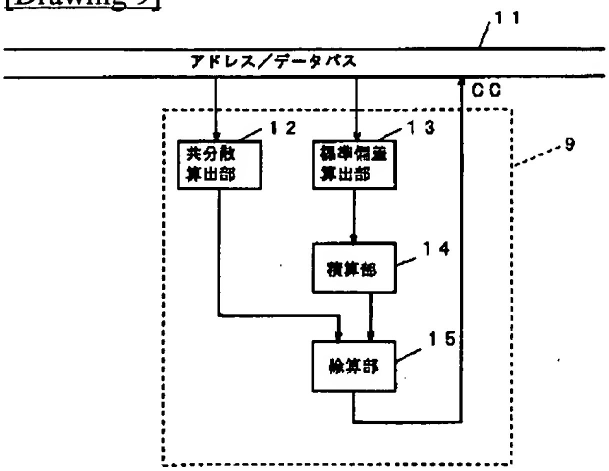
[Drawing 7]

60	60	60	60	60	50	50	60
60	50	50	50	50	60	60	50
100	100	50	50	60	50	50	60
100	100	100	100	100	50	50	50
100	100	100	15	15	15	15	15
100	100	100	15	10	10	10	10
100	100	100	15	10	5	5	5
100	100	100	15	10	5	100	100

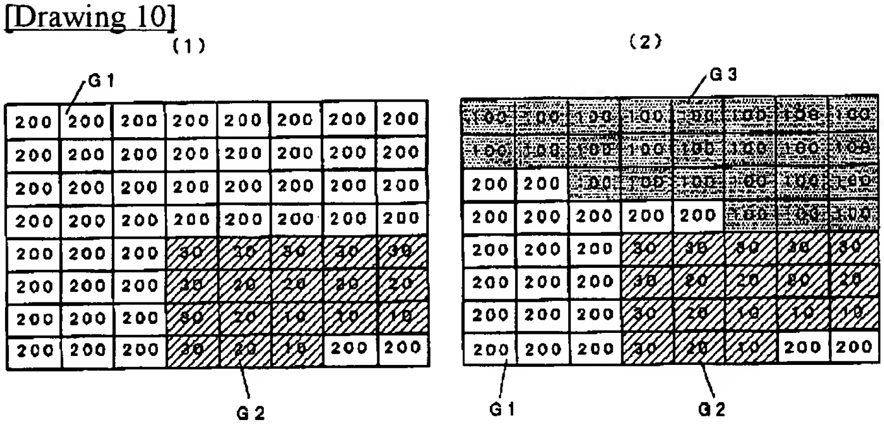
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]